Po!icy, Planning, and Research

WORKING .PAPERS

Population, Health, and Nutrition

Population and Human Resources
Department
The World Bank
July 1989
WPS 246

Causes of Adult Deaths in Developing Countries

A Review of Data and Methods

Richard Hayes,
Thierry Mertens,
Geraldine Lockett,
and
Laura Rodrigues

Little is known about the causes of adult deaths in most developing countries. The authors recommend developing and validating diagnostic algorithms to determine the causes of adult deaths, using lay interviewers to conduct retrospective interviews of relatives of the deceased.

Policy, Planning, and Research

WORKING PAPERS

Population, Health, and Nutrition

Relatively little attention has been paid to the problem of premature adult mortality in developing countries, despite high levels of mortality in many countries — and despite the potentially severe social and economic consequences of adult deaths.

This inattention is reflected in a dearth of information about the causes of adult deaths in these populations. Such information is available from vital registration data in certain Latin American and Middle Eastern countries, but elsewhere — especially in Sub-Saharan Africa and Southern Asia — the sparse information available comes mainly from survey and hospital data and is generally of limited usefulness.

Circulatory diseases and external causes (injuries) appear to be major causes of adult deaths in most countries. The relative contribution of other important causes — including tuberculosis, cancer, liver disease, respiratory disease, and maternity-related complications — varies between countries.

After reviewing methods used in previous studies to diagnose the causes of death in children and adults, the authors recommend developing and validating diagnostic algorithms to determine the causes of adult deaths, for use in single-round surveys, using lay interviewers to conduct retrospective interviews of relatives of the deceased.

Techniques for determining cause-specific adult mortality require thorough field testing and validation. The authors discuss several possible approaches, and categorize selected major causes of death according to whether they are likely to be diagnosed or excluded, on the basis of symptoms reported by relatives. They consider methods for classifying and presenting data on cause of death and conclude with recommendations for further methodological research.

This paper is a product of the Population, Health, and Nutrition Division, Population and Human Resources Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Sonia Ainsworth, room S6-065, extension 31091 (40 pages with charts and tables).

CONTENTS

1. INTRODUCTION

Much attention in recent years has been given to the determination of levels and causes of mortality among children in developing countries. By contrast, relatively little attention has been paid to the problem of adult mortality, despite the potentially severe economic and social consequences of the premature death of adults, both for the immediate family and for the local and national economy. This lack of attention is reflected in a marked lack of information on the levels and causes of adult mortality in developing countries.

In a companion paper (Timaeus and Graham, 1988), methods for measuring the levels of adult mortality in such countries are reviewed and assessed. In the present paper, the focus is on the determination of cause-specific adult mortality. Knowledge of the causes of adult mortality adds considerably to the value of data on overall levels of mortality. It assists with the formulation of intervention strategies designed to reduce mortality in adults, and with the rational allocation of resources between such interventions. Although the health sector is the major beneficiary of such information, it also has consequences for other sectors. For example, data showing high rates of death from road accidents could have implications for transport policy, while a high rate of lung cancer deaths might suggest changes in taxation on tobacco, or other measures designed to reduce levels of smoking.

This paper begins, in Section 2, with a review of the limited information already available concerning causes of death in adults in developing countries. Some information is available from national vital registration data, mainly in countries in Latin America and the Middle East with relatively well developed systems of civil registration. In other countries, and particularly in Sub-Saharan Africa and South Asia, the incompleteness and unreliability of vital registration data mean that existing data on cause-specific mortality come mostly from specially conducted surveys.

Sections 3 and 4 review and discuss methodologies that could be used in countries or areas without reliable registration data to obtain useful data on the causes of adult mortality. Section 3 discusses alternative approaches to collecting such information. These include community-based reporting systems, as well as specially conducted surveys, either single round, multiple round, or involving continuous follow-up of selected communities. Special attention is given to single-round surveys, as it is argued that in the short-term these may provide the most cost-effective approach to obtaining useful data on adult mortality, and that it is likely to be feasible for such surveys to be conducted in a range of developing countries. Consideration is given to aspects of survey methodology, including sampling methods, sample size, choice of respondents and recall periods. Possible biases resulting from the survey methods are also discussed.

In the countries or areas of concern in this paper, the proportions of people that die while under medical care are likely to be low. Ascertainment of causes of death therefore depends mainly on retrospective data obtained by questioning relatives or associates of the deceased. There is some experience of the use of such retrospective questioning with respect to childhood deaths, but less experience for adults. It is thought that adults die from a wider range of causes than children, that many of these causes share similar symptoms, and that the reliable retrospective diagnosis of some causes of death in adults may therefore be problematic. Methodological issues in the diagnosis of cause of death in adults by retrospective questioning are discussed in detail in Section 4. The section begins with a review of previous studies of adult and child mortality based on retrospective questioning. The choice between lay interviewers and physicians is then considered, and the consequences of this choice for questionnaire design. The possibility is discussed of developing algorithms by means of which either medical or non-medical interviewers could arrive at a diagnosis on the basis of reported symptoms. Alternative methods of classifying and of ranking causes of death are also reviewed.

Finally, Section 5 discusses areas that require further research, and suggests techniques that could be used to validate the survey methods reviewed in previous sections of the paper.

Unless otherwise stated, the term "adult" in this paper refers to persons aged 15-64 years. The reasons for this restriction are, firstly, that in most countries this is the age-range in which economic activity and family responsibilities are greatest; and secondly, that the emphasis is on avoidable premature mortality, suggesting that deaths in the oldest age-groups should be excluded. The choice of an upper age limit of 65 years is essentially arbitrary, and it is likely that as death rates at younger adult ages decline, increasing attention will need to be given to deaths at older ages.

The term "cause of death" in this paper refers throughout to medical cause. Investigation of socio-economic, environmental and other risk factors associated with adult mortality is also important, but is outside the scope of this paper.

2. REVIEW OF EXISTING INFORMATION ON CAUSE-SPECIFIC ADULT MORTALITY

2.1 Introduction

This section reviews existing information concerning cause-specific adult mortality in developing countries. The main sources of information are vital registration and surveys, and the availability and limitations of these sources are discussed in Section 2.2. Different sources of information use different systems of classifying cause of death, and Section 2.3 discusses the different approaches, and the consequent difficulties in making comparisons between countries. Finally, Section 2.4 summarises the information on the main causes of death provided by the sources described in Section 2.2, and some general patterns are identified.

2.2 Sources of data

In developed countries, data on cause-specific mortality by age are readily available from national vital registration. Although most of the developing countries also have some kind of vital registration system, levels of coverage and reliability are generally low, particularly outside the main urban centres.

For this reason, few data on cause-specific mortality are available for developing countries in the main international sources, the WHO Statistics Annual and the UN Demographic Yearbook. In the WHO Statistics Annual, which shows cause-specific death rates by age-group and sex, data are available for several of the Latin American countries, where vital registration systems are relatively well developed. In Africa, however, only Mauritius now reports regularly, although data are available from Egypt for 1975. Among the developing countries of Asia, data are available only for Thailand and Sri Lanka, but the data for Sri Lanka appear to be incomplete, no deaths being reported from respiratory, gastro-intestinal, neurological, endocrine, nutritional or genito-urinary causes. More countries are represented in the UN Demographic Yearbook, but data here are for all ages combined, so that the large number of childhood deaths cannot be separated from those of adulthood and old age.

The low coverage of vital registration in many of the developing countries results from several factors, including a lack of incentives to register deaths, and the lack of locally sited offices at which deaths may be registered. A shortage of doctors, especially in rural areas, is often an additional factor in countries where the death certificate has to be completed by a medically qualified person. Where deaths are registered, the usefulness and reliability of the certified cause-of-death are often questionable, partly because many people die at home, often without being given any kind of medical care, and partly because the certification of cause of death is often performed by someone without medical qualifications. This is reflected in the large proportions of deaths classified in ill-defined categories. Even where certification is performed by a physician, its accuracy may not be high. The accuracy of cause of death as shown on death certificates has been shown to be low even in some developed countries, where staff and facilities are plentiful (Alderson and Meade, 1967). Post-mortem studies often show disagreement between clinicians and pathologists. For example, a study in Connecticut, USA, showed a major disagreement on the underlying cause in 29% of deaths (Kircher et al, 1985). Also, inaccurate completion of certificates may result in incorrect classification of the underlying cause of death. Fuller (1985) found in a study in the UK of deaths of known diabetics, that diabetes was mentioned on the death certificate in only 54% of cases. Such under-reporting of underlying causes is likely to be even more serious in developing countries.

Deficiencies in the coverage and reliability of vital registration may lead to considerable distortions in the reported distribution of causes of death. It is probable that deaths from some causes are more likely to be registered than those from other causes. For example, registration of deaths is usually more complete in urban centres, leading to a bias towards those causes of death that are especially common in such areas, but even within a given area there may be a tendency for deaths from some causes to be registered more often. Distortion will also be caused by variations in the reliability of diagnosis of different causes. Thus, deaths from cancer are likely to be under-diagnosed in developing countries because of a lack of facilities and trained staff. On the other hand, reporting of conditions such as tuberculosis (TB), for which relatively well organised control programmes exist, may be considerably more complete. Preston (1976) considered respiratory TB, accidents and violence as relatively robust categories in all populations, whereas he suggested that "other infectious and parasitic diseases" are likely to be under-recorded in areas where registration is unreliable because of a tendency to assign such deaths to terminal conditions such as pneumonia, or tc symptoms such as fever. Deaths from cardiovascular diseases may likewise be assigned to "unknown cause" or "senility".

Vital registration data on cause-specific mortality for Mauritius, Egypt, Sri Lanka and Thailand are reviewed and discussed in Section 2.4. Data are also included for Guatemala, which is one of the higher mortality countries of Latin America.

Apart from national vital registration data, there have been a few studies of cause-specific adult mortality based on sub-national registration data. Most of these again suffer from low coverage and a high proportion of deaths from ill-defined causes. Botha and Bradshaw (1985) analysed registration data for the black population of South Africa. They considered that there was considerable under-reporting of deaths, because the overall mortality rate was lower than expected. Moreover, 20% of deaths were classified as "ill-defined". Vital registration data for Lagos, Nigeria for the year 1977 were analysed by Ayeni (1980). Registration was estimated to be 60% complete, but of the reported deaths 17% were assigned to ill-defined conditions. Finally, Fargues and Nassour (1987) report an analysis of the 55,000 deaths of all ages registered at the Hygiene Office of Bamako, Mali, from 1974 to 1985. No information appears to be given concerning the completeness of registration.

Other data on adult mortality come from specially conducted surveys and from hospital records. Because of the relatively low mortality rate in the adult age-range, either very large samples or very long periods of follow-up are needed to produce a meaningful number of adult deaths for analysis. For this reason, very few published studies give useful data on causes of adult mortality. Methods of diagnosis and classification and the additional errors associated with these are discussed in Section 4.2.

Muller and van Ginneken (1989) report the results of a longitudinal population-based study in Machakos, Kenya. Approximately 4000 households were visited regularly, and 340 deaths were recorded between 1975 and 1978. Data are presented for all ages combined, so that it is not possible to separate the adult deaths from those of childhood and old-age.

A longitudinal study based on an occupational cohort was conducted in Senegal (Borges da Silva, 1987). During a nine year study of the health of a factory workforce, 164 adult male deaths were recorded. Factory employees in developing countries may often be regarded as fairly typical of the general urban population, although the socio-economic characteristics of those employed in the formal economic sector often differ from the large segment of the population engaged in informal economic activities.

Kachirayan (1983) reported a study of cause of death based on deaths registered in Madras, India in 1975 and 1976. Deaths taking place in hospitals, clinics and nursing homes accounted for 27% of all registered deaths, and these institutional deaths were the only ones investigated by cause. In the age-group 15-44 years, 1866 deaths were available for analysis. A second hospital-based study was reported by Williams et al (1986), who analysed the recorded causes of the 1960 deaths occurring in a rural hospital in West Nile District, Uganda during the period 1951-1978. Of these deaths, 679 were of "adults" aged 12 or over, but no data on exact age were recorded and so it was not possible to separate out deaths in adolescence or in old-age from those of adulthood. Both the Madras and the West Nile data are based entirely on hospital deaths, and so cannot be regarded as representative of causes of death in the general population.

One major study has been published that draws together information from a range of sources. The Ghana Health Assessment Project Team (1981) used census data, death certificates, hospital statistics and data from special studies and surveys to estimate the incidence, case-fatality and average age at onset of each cause. These are used to derive estimates of the person-years of healthy life lost from each cause. Data are given for all ages combined. However, rough estimates of cause-specific adult mortality rates may be obtained by restricting attention to those diseases with an average age at onset of 15 years or more, although of course some childhood deaths will be included and some adult deaths will be omitted through this procedure. No details are given of the exact sources of information, nor of the methods by which they have been combined, and it is unclear how reliable the data are likely to be on a national basis.

Finally, Grosse (1980) gives data for specific areas in Ghana, Pakistan, Indonesia and Nepal, but no details are given of the methods by which they were collected.

2.3 Methods of classification

Once data have been collected on the causes of deaths occurring in a defined population, these causes have to be classified into categories for the purpose of presentation. Several different methods of classification have been used in the data sources described above.

Vital registration data are generally presented according to the International Classification of Diseases (ICD). The ICD groups diseases under 17 main headings, each of which is broken down into a large number of categories, each given a 3-digit code. These categories are in turn divided into subcategories represented by a fourth and occasionally a fifth digit. A supplementary classification, consisting of 3-digit codes preceded by the letter "E", is available for external causes of injury and poisoning. Because of the very large number of 3-digit categories, data are often grouped for tabulation according to various abbreviated lists. The ICD is revised every 10 years, the most recent revision being the ninth (ICD-9), published in 1977. These revisions ensure that the classification develops in response to advances in medical science, although differences between the revisions add to difficulties of comparison. This is illustrated by differences in the classification of TB under the abbreviated B and AM lists of the eighth and ninth revisions respectively. Cases included under the TB classifications B5+6 and AM4 differ, in that the late effects of the disease are included in the B classification but not in the AM form. A comparison of TB deaths from the two classifications would therefore show an artefactual decrease in the latter.

An illustration of the difficulty of comparing data based on different classification systems is shown in Table 1, which presents vital registration data for the city of Belo Horizonte, Brazil. This table compares the classification of deaths of all ages under the PAHO ranking "R" list, the Brazilian mortality list ICD-BR, a newly proposed Brazilian list ICD-BR2, and the list of 72 causes of death of the National Centre for Health Statistics of the United States (NCHS). The ICD-BR and ICD-BR2 list give malignant neoplasms as the leading cause of death whereas the R and NCHS lists indicate heart disease as the leading cause. While most of the conditions mentioned in the leading ten causes of death appear on all the lists, diabetes and chronic liver disease are not represented in every case.

For data sources other than vital registration, numbers of recorded deaths are generally small, and broader groupings of causes are therefore needed for data presentation. The groupings adopted have varied widely between studies, partly because of variations in disease patterns between countries, but also because of differences in data-collection methods. For example, if lay interviewers are used to make a diagnosis, a highly detailed classification system is less likely to be appropriate for data presentation. Differences in the classification systems used in different surveys add considerably to the difficulties in making comparisons between countries and areas.

2.4 Summary of available data

Data from vital registration are presented first, followed by data from other sources. As discussed in Section 2.2, very few vital registration data on cause-specific adult mortality are available for the developing countries of Africa and Asia, although rather more are available for Latin America. Table 2 shows the leading causes of death in adults aged 15-64 years for Guatemala, Mauritius, Egypt, Thailand and Sri Lanka. All these countries, however, have considerably higher expectations of life at birth than the less developed countries that are the main focus of this paper, and it is possible that their patterns of cause-specific mortality are also different. The disease categories chosen for presentation in Table 2 are rather broad. This is necessary to allow comparisons between the five countries, as the level of detail in the reporting of data varies considerably from country to country.

Death rates in the age group 15-64 years in these five countries varied from about 3 to 6 per thousand per year. Circulatory diseases and external causes were the two leading causes of death in all the countries shown in Table 2 except Guatemala, where infectious and parasitic diseases were the leading cause, followed by external causes. The term "external causes" in this paper includes deaths from accidents, poisoning, suicide, homicide, and other violence. In Egypt, rheumatic heart disease accounted for a large proportion of deaths from circulatory diseases, especially in women. Pneumonia, other respiratory diseases and malignant neoplasms were also among the leading causes in all four countries where the data were complete. About half the deaths from malignant neoplasms were of unspecified site (range 31% in Mauritius to 65% in Thailand). Restricting to deaths with the site specified, carcinoma of the lung predominated in most of the countries, while carcinoma of the stomach also appeared to be important in Guatemala and Mauritius. In females malignant tumours of breast, uterus and cervix accounted for a high proportion of neoplasms of specified site, although carcinoma of the lung was often equally important. In Egypt, 28% of neoplasms of specified site in females were of the breast and 15% of uterus or cervix. For Guatemala the corresponding proportions were 6% and 30%. These differences in proportions may reflect real differences between countries, but may also be affected by different levels of reporting for different sites. Cultural factors may be important in this context, and under-diagnosis of genital tract diseases in women, for example, may be common in muslim societies. Chronic liver disease and diabetes appeared on the list independently from other gastro-intestinal and other endocrine disorders in most of the countries. "Genito-urinary causes" consisted mainly of cases of nephritis or nephrosis, while chronic obstructive airways diseases accounted for much of the "other respiratory diseases" category. It is surprising to see protein-calorie malnutrition recorded as an important cause of adult deaths in Guatemala.

Cause-specific mortality should be considered separately for different age groups whenever possible, as the importance of some diseases varies with age. In Egypt, for example, circulatory diseases accounted for 30% of deaths in those aged 15-44 years, but for 46% in those aged 45-64 years. The equivalent percentages for deaths from external causes were 19% and 4% respectively. Overall, for ages 15-64, 10% of deaths were due to external causes. If this were the only value considered, the great importance of external causes in the younger age groups might not be clear.

Similarly, when mortality data for both sexes are considered together, as in Table 2, maternal causes (which include all deaths relating to pregnancy, childbirth, or the puerperium, including those due to abortion) usually do not feature in the list of leading causes of death, whereas if data for females are considered separately, maternal causes frequently rank quite highly. This is illustrated in Table 3, which shows the data for Guatemala and Egypt by sex. In females, maternal causes appeared in the leading ten causes of death, although their importance is still likely to be underestimated because maternal mortality is generally under-reported. Deaths in early pregnancy are often misclassified and deaths related to abortion may be concealed. Thus, a survey conducted in Menoufia, Egpyt, found 382 of 1979 deaths (19.2%) among females to be due to maternal causes (Grubb et al, 1988). When the death certificates were examined, however, only 121 (6.1%) of the 1979 were reported as maternal deaths. Many of the remaining deaths were classified under circulatory diseases on the death certificate.

Other sex differences are apparent when data for males and females are analysed separately. For example, deaths due to accidents and violence are usually more common in males, although in Egypt deaths due to accidents involving fire are considerably more common in females. Cirrhosis and other chronic liver diseases appear to be more common in males.

All national vital registration data mask variations in cause-specific mortality between different areas within a country. In Brazil in 1984, for example, intestinal infectious diseases were the leading cause of death (for all ages combined) in the state capitals of the Northeast, but did not appear in the leading ten causes in the state capitals of the South or Mid-West (PAHO, 1988).

Turning to registration data for sub-national populations (Table 4), there are difficulties of comparability because different reports use different disease groupings. In their report of data for the black population of rural South Africa, Botha & Bradshaw (1985) only give the percentages of deaths accounted for by six of the main headings of the ICD. External causes accounted for 30% and circulatory diseases for 18% of all adult deaths. External causes and circulatory diseases were also the two leading causes of death in Lagos, Nigeria (Ayeni, 1980). Motor vehicle accidents alone accounted for 26% of deaths of persons aged 15+, while circulatory diseases accounted for 20%. Fargues and Nassour's (1987) analysis of deaths registered in Bamako, Mali gives death rates by five-year age-groups for 13 cause categories. Table 4 shows a crude average of the death rates for the age-groups from 15 to 64 years, indicating the most important causes of adult death to be liver disease, cardiac insufficiency, TB and intestinal infectious diseases.

Table 5 summarises the leading causes of death from sources other than vital registration. Comparison of the results of these studies is subject to serious difficulties because of widely differing methods of classification and tabulation. This is exemplified by the hospital data from West Nile District, Uganda (Williams et al, 1986). Data are given only for those individual causes of death associated with 30 or more deaths, and this accounts for only 312 of the 679 adult deaths. The leading causes of death recorded in this hospital study were schistosomiasis, pneumonia and gastrointestinal diseases, together accounting for about 25% of the deaths. It is surprising that no deaths from circulatory disease or external causes appeared among the leading causes in this study. These data, however, should be interpreted with great caution in view of the substantial presentation biases inherent in a study of deaths at a hospital covering a large rural catchment area. In the other hospital-based study in Madras, India, TB, suicide and cardiovascular disease were the leading causes of death. If deaths from suicides and accidents are added, external causes were clearly the leading cause of death in this study. It is of interest that of deaths from external causes, over half the male deaths and nearly all the female deaths were attributed to "suicide and self-inflicted injury".

The longitudinal study of factory workers in Senegal (Borges da Silva, 1987) showed liver disease to be the leading cause of death, as in the report from the neighbouring country of Mali described above, accounting for 41 (25%) of the 164 deaths. Carcinoma of the liver accounted for 22 of these deaths, hepatitis for 10 and cirrhosis for 9. In Table 5, these deaths have been reclassified such that, as in most official statistics, carcinoma of the liver is included under neoplasms and hepatitis with infectious diseases. Borges da Silva gave separate figures for accidents at work (13% of deaths) and other accidents (10%). When these are combined, accidents again become the leading cause of death in this population. This provides another example of the effects of differing classification schemes.

In the data from Machakos, Kenya, circulatory disease, TB and neoplasms were the three leading causes of death, together accounting for about 34% of deaths, although these data are for the age range 5 years and over, and so will include deaths in older children and the elderly. Data from the Ghana Health Assessment Project have been examined by restricting attention to those causes with an average age at death of 15 years or above. By multiplying the incidence rate by the case fatality rate for each cause, an estimate is obtained of the cause-specific mortality rate for adults. On this basis, circulatory diseases appear as the leading cause, followed by accidents and "other diseases of the gastro-intestinal tract". It should be emphasised, however, that some childhood deaths and all deaths of old-age are included in these calculations, and the data are therefore not directly comparable with those from other studies. Note that in the data from Machakos and Senegal, circulatory diseases include both cardiovascular and cerebrovascular deaths, while these are shown separately for Madras and the Ghana Health Assessment Project. It is of interest that in Ghana, cerebrovascular deaths ranked second in importance, while they were relatively unimportant in Madras, and not among the ten leading causes.

The data published by Grosse (1980) show widely differing rankings of the leading causes of death in the four study areas (Table 6), but are difficult to interpret in the absence of detailed information on study methodology. The leading reported causes were enteric fever in the Punjab, maternal causes in E. Java, circulatory diseases in Eastern Region of Ghana, and TB in Terai, Nepal. The absence of any reported deaths from external causes, except in Nepal, is surprising, and in the case of Ghana conflicts markedly with the findings of the Ghana Health Assessment Project which indicated accidents to be the third most important cause of adult death. The absence of deaths from neoplasms in all four areas is also surprising, although it should be emphasised that these studies were restricted to the age range 15-44 years.

On the basis of the available data, only a number of general conclusions can be reached concerning the leading causes of adult death in developing countries. It seems clear that circulatory diseases and external causes are leading causes of adult death in nearly all the populations studied. There appear to be some interesting variations of detail, for example the very high rates of death from motor vehicle accidents in Lagos, Nigeria, and the large proportion of deaths from external causes that were attributed to suicide in the data from Madras, India especially among women. Other important causes that appear repeatedly are TB and neoplasms. Liver disease appeared especially important in some reports from Africa. Respiratory diseases and maternal causes were also important in some populations.

More striking, however, was the overall lack of information on causes of adult mortality, particularly in the developing countries of Sub-Saharan Africa and Asia, and especially in rural areas. Vital registration data for such populations are almost completely lacking, and very few special surveys have been conducted. Those which have been conducted have met difficult methodological problems, and are difficult to compare because of differing methods of classification. There is therefore a clear need for an initiative to explore possible methods of producing reliable, useful and comparable data on causes of adult mortality, that could be applied in a wide range of developing countries.

3. SURVEY DESIGN FOR THE MEASUREMENT OF CAUSE-SPECIFIC ADULT MORTALITY

3.1 Introduction

The measurement of adult mortality and its causes poses three fundamental problems that are not encountered in the case of childhood mortality. Firstly, adult deaths are relatively rare events, and large sample sizes are therefore needed to provide precise mortality estimates. Even larger samples are needed to provide a reliable indication of the percentage of deaths attributable to each cause. Secondly, unlike childhood deaths for which the mother or guardian is the natural informant, for adult deaths there is no single relative or associate that can always be used as an appropriate informant. Thirdly, it may be more difficult to obtain a reliable diagnosis through retrospective questioning for adult deaths than for childhood deaths. The first two problems, and other survey design issues are discussed in this section. Problems associated with the diagnosis and classification of causes of death are discussed in Section 4.

Given the need for reliable data on cause-specific adult mortality in developing countries, there are three basic approaches. The first is to take steps to increase the coverage and reliability of national systems for the collection of mortality data. In many countries, coverage levels of the formal vital registration system are currently extremely low outside the main urban centres. An alternative method of increasing coverage in rural areas would be to involve primary health care workers in the maintenance of records of the births and deaths occurring in the communities for which they are responsible. Such community-based reporting systems might encourage a better understanding by health care workers of the communities they serve, and thus contribute to the development of effective primary health care. The gradual development of effective national systems for the collection of mortality data, either via community-based reporting or some other approach, should certainly be seen as an important long-term goal. Given the extensive training, supervision and coordination required to establish systems of this kind on a nationwide basis, however, such a process will clearly be lengthy. It seems very unlikely, therefore, that such an approach will yield useful and reliable data on adult mortality in the immediate future.

A second alternative is to make use of statistics collected at health care facilities. These data should not be neglected, but refer more often to morbidity than mortality, and may be affected by important biases. People attending hospitals or clinics are often unrepresentative of the general population. Use of a health facility will depend on the accessibility and acceptability of the services offered, and on their cost, both in terms of expenditure on treatment or transport and in terms of opportunity costs. These in turn will be affected by factors such as socio-economic status, ethnic group, perceptions of illness, and the attitudes of medical staff. In addition, attendance may be determined by the type of complaint. For example, patients may be more likely to be taken to a health care facility after an accident than with a chronic illness. Where the majority of deaths do not occur in hospitals or clinics, health facility statistics are likely to give a very distorted picture of causation.

Specially conducted surveys may therefore provide the most fruitful approach in the short-term. Special surveys have several advantages over alternative approaches. Firstly, it is possible to concentrate resources on obtaining data of high quality over a limited time period. It is easier to maintain high standards of training and supervision over a short time period than in a permanent routine system. Secondly, it may be feasible to develop uniform survey instruments that could be applied in parallel surveys in several countries, although some local variations might be necessary. This should allow useful comparative studies of patterns of mortality in different geographical regions. Thirdly, it is possible in a specially conducted survey to obtain information not only about mortality rates, and causes of death, but on a range of socio-economic, demographic, environmental and other factors of interest. This would allow an analysis of the determinants and consequences of adult mortality.

Two basic types of survey are possible in this context. In a single-round survey, a sample of households is visited, and questions asked about adult deaths that have occurred in the past. In a multi-round survey, the same households are visited repeatedly, so that deaths can be recorded prospectively. Single-round surveys are considered in Section 3.2, and multi-round surveys in Section 3.3.

3.2 Single-round surveys

3.2.1 Indirect demographic methods and cause-specific mortality

The most obvious method of estimating mortality rates in a single-round survey is to question the head of each household about deaths that have occurred in the household during a specified period. Experience in demographic surveys, however, has shown the use of the household head as respondent to be unsatisfactory. Under-reporting of deaths occurring during the preceding twelve months is common (Blacker, 1984), and results from several factors, including reference period errors, cultural influences leading to a reluctance to talk about deaths, and simple omissions. An additional problem is that an adult death often leads to the fission or regrouping of the household, so that the household in which the death occurred may not exist by the time of the survey.

In an attempt to overcome some of these difficulties, demographers have developed a range of techniques for the estimation of mortality rates known as "indirect methods". Using these methods, estimates of adult mortality are derived from data on the survival of close relatives, and represent averages of the mortality experienced over the period during which the relatives were exposed to the risk of dying (United Nations, 1983). Characteristics of the respondent, especially their age, are used in the analysis, rather than characteristics of the deceased. Asking respondents about the survival of specific relatives appears to lead to more reliable results than asking household-heads about deaths in the household during the preceding year. Moreover, a smaller sample size is possible, because the respondent can be questioned about the survival of more than one relative over a longer period of time.

The sibling survivorship method has been adapted to estimate the rate of mortality from maternal causes (Graham et al, 1988), and Timmaeus and Graham (1988) suggest that indirect methods could be similarly adapted for the estimation of mortality rates from other causes. There are two major difficulties with this approach:

(i) The indirect methods involve questions concerning deaths to relatives that occurred at any time since they reached adulthood, implying a long recall period for many of the deaths. A short recall period is likely to be needed, however, for the reliable retrospective diagnosis of most causes of death.

(ii) The indirect methods involve questions about relatives that may have lived in different households from the respondents, who may therefore know little or nothing about the circumstances of death. It is probable that only respondents who lived in close proximity to the deceased prior to the death are able to give adequate information about the cause of death.

Thus the factors that lead to advantages in the use of indirect methods for the study of the level of adult mortality, are obstacles in a study of cause-specific mortality.

Nevertheless, the basic approach of questioning all household members about deaths to their relatives still has advantages for a single-round survey of causes of death. Firstly, it obviates the difficulties mentioned above connected with the reformation of families following a death. Secondly, the head of household may often be less able than a specified relative to provide detailed information about the death.

This suggests that a fruitful approach might be to question all adult members of each household concerning deaths of specified relatives, but to restrict cause of death questioning to deaths that satisfy a number of additional criteria relating to the time at which the death occurred, and the proximity of residence of the deceased and the respondent at the time of death. In this way, the same survey could be used both to provide estimates of overall levels of adult mortality, and to estimate the proportions of deaths attributable to different causes. This possibility, and various problems and biases that may result, are discussed in the sections that follow.

3.2.2 Selection of respondents

Respondents should be restricted to those aged 15 years or more, as children are unlikely to be able to provide reliable information about the symptoms and circumstances relating to an adult death.

In principle, it would be possible to ask each respondent about the survival of just one type of relative. The spouse might be the most obvious choice, as spouses generally live together and could therefore be expected to report reliably on symptomatology. In Senegal, for example, spouses and parents were able to provide information leading to a diagnosis in 41% of cases, compared to 19% for other respondents (Garenne and Fontaine, 1986). There are, however, some disadvantages in questioning solely about spouses. In some societies, the definition of "spouse" is not always clear, especially in urban areas in which informal unions are common. Where divorce or separation are common, there may be confusion as to which spouse is intended, and respondents may be unable to report on the symptoms surrounding the death of a former spouse. Moreover, in the case of female deaths, the main carer in some societies tends to be a daughter or sister rather than the husband. Certainly it has been suggested in the context of studies of maternal mortality that sisters are better respondents than husbands (Graham et al, 1988). Finally, deaths of single adults would be missed completely.

It may be preferable, therefore, to question respondents about the survival of all their close relatives. This could include spouses, siblings, children that have reached adult age, and parents.

Further questioning, about the symptoms associated with a death, would be restricted according to the time of death (see Section 3.2.3), and the proximity of residence of the respondent and the deceased. Criteria for proximity would clearly include those who were living in the same household at the time of death. It is less clear whether respondents living in the same village or neighbourhood as the deceased would be acceptable, and this point requires further research.

3.2.3 Recall period

Given that adult deaths are relatively rare events, the use of a long recall period would be of benefit in reducing sample size. However, detailed information about the illness preceding death is unlikely to be recalled over a long period of time. The optimal recall period for surveys of cause-specific mortality must therefore be considered.

Most reported work on retrospective cause-of-death enquiries ("verbal autopsies") has been carried out in studies of deaths in childhood. They have usually involved questioning the mothers of dead children, or some other relative if the mother was unavailable. In Senegal, Garenne and Fontaine (1986) found that both the response rate, and the percentage of deaths for which cause was specified, were greatest when the interval between the death and the interview was between three and eight months. Zimicki (1989) in Bangladesh found that intervals of up to ten months did not affect the amount or quality of information obtained, and suggested that, as distress may be caused by asking about a death soon after its occurrence, it may be preferable to wait several months. Bradley and Gilles (1984) conducted interviews within one month of the death, and Greenwood et al (1987) used intervals of up to three months. The latter felt that information obtained more than three months after death would be unreliable.

It generally seems to be accepted, therefore, that recall periods exceeding one year are inadvisable for child deaths. It is possible that in some societies the premature death of an adult is seen as a more significant event in the family than the death of a child, and that it may therefore be possible to use a longer recall period when questioning relatives about adult deaths. It may also be argued, however, that a mother may be more intimately involved in the care of a sick child, and therefore better able to give details of symptoms, than would a relative caring for an adult. This would suggest that a shorter recall period might be necessary in a study of adult deaths. In some cultures the first anniversary of a death is an event of great significance thus making the first year after a death a clearly defined period. Recall may also be more reliable in that period than subsequently if the period of mourning serves to keep the memory of the death fresh until the final rites are observed. Further research is clearly required on an appropriate choice of recall period for adult deaths.

Some causes of death, in particular external and maternal causes, do not require any knowledge of symptomatology. Consideration should therefore be given to the possibility of adopting less stringent criteria for recall period and proximity of residence for selected causes of death. This option is discussed further in Section 4.5

3.2.4 Sampling methods

A decision would be needed on the definition of the population of interest. This could be the entire population of a country, it could exclude urban areas if these were already well covered by vital registration, or could be restricted to some sub-national area. The sampling procedure would be chosen with the aim of giving a representative sample of the defined population.

Given the lack of reliable sampling frames in most developing countries, some form of multi-stage sampling is the most likely alternative for a single-round survey. The basic approach would be to select communities with probability proportional to size, and then to sample a fixed number of households or persons in each selected community.

The required sample size needs careful consideration. It is considered that data would need to be collected on at least 200 deaths in order to provide reasonably accurate information on the proportions of deaths attributable to different causes. Assuming a death rate in adults aged 15-64 years of roughly 5 per thousand per year, it follows that a population of about 40,000 adults would be needed to produce 200 deaths in one year. If questioning were to be restricted to those living in the same household as the deceased, this would mean visits to enough households to provide a total adult population of about 40,000. The number of households would thus depend on average household size. In a community with an average of two adult members per household, a sample size of around 20,000 households would be required. Demographic surveys using indirect methods typically require sample sizes of between 3,000 and 10,000 households, and this demonstrates that somewhat larger samples are likely to be needed if reliable data on cause-specific mortality are to be obtained. Even larger samples would be needed if detailed comparisons were to be made in patterns of cause-specific mortality between different age-groups or geographical areas.

3.2.5 Sources of error

There are several potential sources of error that need attention. Firstly, there is the problem of multiple reporting. This could occur, for example, if two siblings living in the same household both reported on the death of a parent. In an extreme case, the same death might be reported by the spouse, the siblings and the parents of a young adult, if they all lived in the same house. If the criteria for questioning were to be relaxed to include deaths of relatives living in the same neighbourhood, and not just the same household, the scope for multiple reporting would be even greater. Allowing multiple reporting would lead to a potential bias, since deaths of persons with a large number of close relatives would be greatly over-represented in the data, and the distribution of causes of death may vary with family size.

Within the household, multiple reporting could easily be avoided by instructing interviewers to submit at most one report for each death. Rules would be needed as to which report to adopt. If one of the respondents personally cared for the deceased, their report would obviously be preferred. If questioning about deaths occurring in the same neighbourhood were allowed, careful cross-checking of data would be necessary at the analysis stage to detect and remove multiple reports. In the latter case, comparison of diagnoses reached on the basis of reports on the same death by different respondents might provide a useful check on validity.

Even if multiple reports are eliminated, bias is still possible. A dead person will be covered by the survey if a household is sampled which contains respondents qualified to report on the death. Those without any surviving close relatives, or who were not living in close proximity to a close relative at the time of their death, will be totally excluded, although it is thought this will be a relatively small proportion of adult deaths in most countries. If household fission followed a death, qualified respondents might live in a number of households by the time of the survey, and such deaths would therefore be over-represented. If questioning about deaths outside the household but in the same neighbourhood were to be allowed, deaths to persons with relatives in several houses in the neighbourhood would be over-represented relative to those whose relatives all lived in the same house. This could be an important source of bias given that mortality patterns in migrants, who are less likely to have relatives living in other households in the neighbourhood, are often different from those of established residents.

For similar reasons, it is possible that deaths at some ages may be over-represented relative to deaths at other ages, since the probability that surviving close relatives are available to report a death may vary according to the age of the deceased. This would lead to a distortion in the overall distribution of adult deaths by cause, since the distribution of cause varies with age (see Section 2.4). This may not be a serious problem, however, if the distribution of causes is analysed in broad age-groups. This could be done either by asking the respondent to make a rough estimate of the age of the deceased, or by inference from the age-group of the respondent and the type of relationship. Note that it would not be feasible to use more than two or three broad age-groups given that only about 200 deaths are anticipated in total. Thus, although there are severe difficulties in obtaining reliable ages in many developing countries, it should be possible to classify most of the deaths into broad age-groups with reasonable reliability.

A further source of bias is the possibility that respondents may misreport the times at which deaths took place. Thus some deaths occurring within the prescribed recall period may be missed, and others occurring outside the period may erroneously be included. Although this could have an important effect on estimation of rates, it seems unlikely to lead to serious distortions in estimating the proportions of deaths due to different causes.

The net effect of these biases is thought unlikely to be severe, but they require further investigation.

3.3 Multi-round surveys and continuous follow-up

The focus thus far has been on single round surveys, because they are relatively simple and inexpensive to conduct, and because it seems feasible to envisage the implementation of surveys of this kind in a range of developing countries. Brief consideration is given in this section to various alternative approaches.

Multi-round surveys involve repeated visits to the same sample of households. They avoid some of the difficulties inherent in single round surveys. Because the population at risk is clearly delineated at the first round, it is in principle possible at subsequent rounds to determine the vital status at follow-up of the complete sample, and thus to achieve complete ascertainment of all adult deaths occurring in the sampled households during the intervening period. For each ascertained death, the most appropriate reporter can then be selected and questioned with regard to symptomatology. This approach avoids the potential bias resulting from deceased persons with differing numbers of surviving relatives. It also ensures that attention is restricted to deaths occurring within the desired reference period.

However, the advantage of having a clearly delineated population at risk is lost where there is substantial migration, because then the population is not fixed but dynamic. Particular problems may result when complete households leave the area during the follow-up period, firstly because it may be difficult to establish whether any deaths occurred prior to their departure, and secondly because suitable reporters for any such deaths will not readily be available. This may be a serious source of bias if it is common for households to break up following the death of an adult member.

A further issue concerns sampling procedures. Because of the logistical difficulties involved in locating the same households for follow-up at successive surveys, multi-round surveys are most commonly conducted in a limited geographical area, often involving the complete population of a few selected communities. This contrasts with single round surveys, in which it is feasible to use multi-stage sampling techniques to provide a sample that is representative of the entire country.

Finally multi-round surveys are more costly, more time-consuming, and more complex to organise given the need to link data from one round to the next.

Another alternative is to collect mortality data through systems for the continuous follow-up of a community. If all households are visited routinely on a regular basis, it is possible to record all deaths that occur in the population during a specified period. Changes in the denominator population can also be recorded as they occur. When a death occurs, the household can be visited within a planned interval of time, and the most appropriate respondent chosen to report on symptomatology. While this approach is attractive, it has several disadvantages as a method for the measurement of cause-specific mortality. Firstly, the intensive follow-up of the community may itself result in a modification of mortality patterns relative to the general population. If field-workers visit a household when an adult member is severely ill, there would be considerable pressure to assist with transport to a medical facility. Secondly, as with multi-round surveys, continuous follow-up studies are generally restricted to the entire population of a limited geographical area, thus reducing their representativeness with regard to the general population. Thirdly, deaths among adults are rare events, and field-workers may tire of asking routine questions that almost always result in negative responses. Thus while it is important to improve the quality of data collected through continuous follow-up systems, these are not the method of choice for the provision of nationally representative data on cause-specific mortality.

4. COLLECTION, CLASSIFICATION AND PRESENTATION OF DATA CONCERNING CAUSE OF DEATH

4.1 Introduction

This section focuses on methods for the retrospective diagnosis of cause of death by questioning relatives about the symptoms associated with the death. Techniques used in previous studies of cause-specific mortality are reviewed with respect to the choice of interviewer, questionnaire design, and the diagnosis and classification of cause of death. This is followed by a discussion of the prospects of obtaining a diagnosis of some of the major causes of adult death on the basis of symptoms reported by relatives. The section ends with a discussion of alternative methods of presentation of cause-specific mortality data.

4.2 Techniques used in previous studies.

Several studies in the past decade have attempted to establish causes of death through retrospective interviews of relatives of the deceased.

In Nigeria, Bradley and Gilles (1984) used enumerators with at least 7 years of schooling to interview a relative of the deceased within one month of the death. The presence or absence of each of a list of 25 symptoms was recoreded, but no additional questions were asked. Of 52 deaths of adults aged 15-44 years, 42 were recorded as due to ill-defined conditions, while in children ill-defined conditions accounted for 106 of 151 deaths. Other causes were reported in broad categories only, suggesting that this form of questioning was inadequate for detailed classification of cause of death.

In Senegal, Garenne and Fontaine (1986) used interviewers with 4-7 years schooling and of the same ethnic group as the study population. A structured questionnaire covering all major symptoms was used, and the cause of death as stated by the relative was also recorded. If a symptom was present, additional questions were asked concerning the timing and duration of the symptom. Supplementary information was obtained by asking about any treatment received, and by seeking corroborating evidence such as old medicine bottles. Each questionnaire was then studied by two physicians, each of whom made a diagnosis of cause of death before agreeing on a final classification. The authors listed for each death a "probable main cause", "probable immediate cause" and "probable associated causes". Only in a minority of cases did the latter two causes provide useful additional information. The term "probable main cause" was not exactly equivalent to the "underlying cause" of the ICD, but in most cases the classification would have been the same. Rules had to be developed to arrive at a main cause and a causal sequence for certain combinations of symptoms, for example the complex of measles, cough, and diarrhoea in childhood. Results were published in terms of single main causes, but additional information on causal sequences was available. The authors emphasised that epidemiological evidence of diseases prevalent in the area at the time "added a lot of accuracy". This research covered both childhood and adult mortality but the authors felt that results for adults were less reliable. In adults aged 15-49, questionnaires were completed for 74.5% of the cases, but a diagnosis was reached for only 28.9% of cases for which a questionnaire was obtained. In those aged 50 years, questionnaires were completed for 60.0% of cases, but a diagnosis was reached for only 21.6% of these.

In Bangladesh, Zimicki (1989) used a list of 16 symptoms and asked auxiliary questions if a symptom was present. In addition, the stated cause and circumstances of the death were recorded, and the relative was asked whether the deceased was fat, normal, or getting thin. Zimicki states that data collection was separated from classification, but it is not clear from the published report who the interviewers were or by whom the classification was carried out. Results for each death were presented as multiple causes grouped into "very likely causes", "likely causes", and "excluded causes". An attempt at validation was made by comparing results with those obtained from in-depth interviews by a physician. It was concluded that the system works well for causes such as diarrhoea, for which the medical diagnosis and perception of illness are the same.

In a study of 184 childhood deaths in The Gambia (Greenwood et al 1987b) physicians visited and interviewed bereaved relatives, within three months of the death where possible. At each interview, the physician took a detailed history and made a preliminary diagnosis. Any available clinic or hospital reports were then reviewed before a final cause of death was designated from a list of 20 diseases and clinical syndromes. Clinical records were available only for a few children. The final records were reviewed independently by 3 physicians with 96% agreement as to the cause of death. Of the 184 deaths, cause was recorded as unknown in 19 cases, a much lower proportion than in the other studies reviewed here. Diagnosed conditions included acute respiratory infections, malaria, meningitis, meningococcaemia, malnutrition and/or chronic diarrhoea, acute gastroenteritis, measles, septicaemia and chronic respiratory problems. The authors stated that using a physician as interviewer allowed the pursuit of diagnostic clues that may not be noticed by a lay interviewer.

Accuracy in the identification of specific diseases varied between studies, and seemed to depend on the prevalence and cultural perception of diseases at each site. Thus Garenne and Fontaine (1986) found that in children, measles, diarrhoea and epilepsy were well identified by relatives whereas malaria and meningitis proved more difficult. For the latter they suggest that the difficulty may have been due to the local tendency to assign the symptoms and signs of meningitis to magic. In The Gambia, however, Greenwood (1987a) felt that malaria was well identified, an impression confirmed by a validation study reported by Alonso et al (1987). All the studies agreed in delineating diarrhoea as the most easily diagnosed cause of death in childhood.

4.3 Choice of interviewer

Consideration needs to be given to the choice between using a qualified physician or a lay interviewer to question the relatives of the deceased. This choice may depend on the number of deaths expected and the local availability of qualified physicians. Section 3.2.4 shows that the number of deaths detected in a single-round survey of manageable size is unlikely to exceed 200-300. It may therefore be feasible to employ a physician to conduct the cause of death interviews. A physician may be able to use a relatively unstructured questionnaire, pick up clues concerning the death and ask supplementary questions in a way that would be impossible for a lay interviewer. By contrast, the results of previous studies suggest that if lay interviewers are to be used, a carefully designed, highly structured questionnaire is needed. The choice of interviewer is therefore linked with the choice of which type of questionnaire is to be used.

Familiarity with the culture and language of the respondents is usually required of a good interviewer, but is specially relevant when sensitive questioning of bereaved relatives is required and when, as in this case, a bridge may have to be built between the medical concepts of the respondents and those of "western" medicine. The preferred gender of interviewers also needs consideration, but may vary between different survey populations.

4.4 Determination of cause of death

This section focuses mainly on methods for the retrospective diagnosis of cause of death using structured questionnaires and lay interviewers. If physicians are employed to interview relatives of the deceased, it may be possible to work with a less structured questionnaire, allowing the physician to follow diagnositic clues. It may be, however, that even in this situation a structured approach, possibly with an opportunity for the physician to ask supplementary questions at the end of the interview, would yield more reliable results, and this point requires further research.

A respondent is likely to view the cause of death of their deceased relative in terms either of symptoms, or of "diseases" defined according to local cultural concepts which may differ from the "western" medical model. For this reason, the determination of cause of death by questioning of relatives is likely to be based mainly on questions concerning symptoms rather than diseases. The only exceptions will be those causes, such as external and maternal causes, which do not depend for their diagnosis on details of symptomatology.

A structured questionnaire can take the form of a simple checklist of symptoms, where presence or absence of each is recorded without further supplementary questions. Alternatively the symptoms reported may act as a "filter" defining what else is to be asked (Kalter et al, 1989): additional questions may be asked about each symptom that is reported; or a more complex structured questionnaire could be used based on diagnostic algorithms. Other evidence, such as clinical reports or medicine packages can also be reviewed. Whatever the form of the questionnaire, health-workers and anthropologists with local knowledge need to be involved in its development and adaptation to local circumstances.

For most causes of death, diagnosis will rest on the availability of detailed information regarding the symptoms and circumstances leading to the death. While some diseases are fairly easily recognised by a particular complex of symptoms, not all cases of diseases exhibit all the symptoms in the complex. Physicians usually take account not only of symptoms, but also of previous medical history, family history, occupational history, social history and physical signs when reaching a diagnosis. Some of these could also be reported by a relative.

Any individual symptom can be caused by many diseases as illustrated in Table 7. Breathlessness, for example, could be caused by pneumonia, cardiac failure, asthma, a pneumothorax, lung cancer, TB or severe diabetes, to mention but a few. If an accurate history can be obtained it may be possible to distinguish between them. Information would be required regarding the onset, severity and duration of breathlessness and associated symptoms. The onset of breathlessness due to a pneumothorax would be dramatic, within minutes. That of pneumonia or asthma would be acute, within hours. With lung cancer the onset of breathlessness is likely to be sub-acute, occurring over several days. The person with pneumonia will be breathless even when sitting quietly at rest, will usually have fever and may have chest pain and a cough. With cardiac failure the breathlessness would be noticed on exertion or when lying flat, and be associated with swelling of the ankles or lower legs. The duration of symptoms may help to distinguish between pulmonary TB and lung cancer, both of which can lead to weight loss, cough, blood-stained sputum and fever, because the history of illness with TB may be of several years duration, whereas with lung cancer it may only be of months. These brief examples show how the cause of death in someone complaining of breathlessness can be classified more accurately than "probable respiratory system disease" if detailed information is available from a respondent who had close contact with the deceased. In Table 7, nc attempt is made to provide a complete list of all possible causes of death associated with each symptom, but rather to display a selection of causes which may have public health importance in different settings.

Table 8 represents an attempt to categorise selected major causes of death according to whether they are likely to be diagnosed or excluded based on symptoms reported by relatives. Clearly the possibility of exclusion of a diagnosis depends on whether the deceased suffered from a condition with similar symptoms. For example, stomach cancer could be excluded if the deceased had been well until shortly before death and suddenly developed a severe respiratory infection which proved fatal, but could not be excluded if the deceased in addition gave a history suggestive of a chronic peptic ulcer. The potential value of the exclusion category is that it provides an upper limit to the rate of mortality from any given cause.

In 1978, the World Health Organization produced a list of symptoms associated with possible diagnoses, for use in the lay reporting of morbidity and mortality (WHO, 1978), stating that the list was to be regarded as an example needing modification and adaptation to fit differing local circumstances. Garenne and Fontaine (1986) and Zimicki (1989) have pointed out the limitations of this list.

An alternative approach to the collection of detailed information on symptomatology is the use of diagnostic algorithms (Essex, 1980). These have been used mainly in developing countries, to assist paramedical workers with the diagnosis and treatment of common illnesses. They are based on step by step exclusion of possible alternative diagnoses for each symptom reported by a patient. An algorithm is provided for each of the major common symptoms, for example cough, fever, oedema, weight loss and so on. The interviewer works through the algorithms corresponding to each of the principal symptoms experienced by the deceased, and the final diagnoses given by these algorithms should agree. An example of a diagnostic algorithm is given in Figure 1.

How applicable existing algorithms developed for the questioning of living patients are to the retrospective questioning of surviving relatives remains to be ascertained. The available algorithms would require adaptation for this purpose, and this would be a major undertaking. The number of diagnoses would need to be reduced to encompass only fatal diseases, and pathways adapted to permit broader diagnostic groupings in cases where the presence or absence of particular symptoms cannot be determined. Algorithms may need to be country- or area-specific because of variations in the endemicity of different diseases. Extensive field testing and validation would be required to establish how appropriate algorithms are in this context. The development of a set of algorithms for the determination of cause of death based on symptoms reported by surviving relatives that proved to be valid in a range of settings would represent a valuable addition to the tools available for epidemiological work in developing countries.

The use of algorithms would require more highly trained interviewers and a lengthier interview. Computer programs have been developed for use with small portable computers in order to facilitate the use of diagnostic algorithms in the field, and the feasibility of this approach needs to be assessed (Zimicki, 1989).

Consideration needs to be given to when and by whom the actual diagnosis of cause of death is to be carried out. If the interview is performed by a physician, it is likely that a diagnosis can be made during the interview. If a lay interviewer is employed, the recorded symptoms could be examined subsequently by a physician in order to reach a diagnosis. Alternatively, if clear rules could be established for the assignment of diagnoses to symptoms and combinations of symptoms, diagnosis could be performed subsequently by a lay person, or using a computer program. If diagnostic algorithms are used during the interview, it should again be possible to arrive at a diagnosis at the end of the interview. Making a diagnosis during the interview clearly has the advantage of minimising the number of steps in the processing of information.

4.5 Classification of cause of death

Because the number of deaths from most individual causes is likely to be small, and because it will often be impossible through a retrospective interview to distinguish individual causes with similar symptomatology, it will be necessary for deaths to be grouped into classes for purposes of analysis and presentation.

Diseases can be classified either according to the organ or physiological system involved, or according to the pathological process, for example tumour, infection or degeneration. To be most useful, classification is likely to involve a combination of both, because either system alone would be inadequate for purposes of policy and planning. For example, although it would be of interest to determine that the majority of adult deaths in a given area were due to neoplasms, the information would be more useful if the sites of the tumours were known. An excess of lung cancer might point to smoking as a problem to be tackled with some urgency, or a high incidence of liver cancer might be related to a high prevalence of Hepatitis B and lead to consideration of a vaccination policy. Conversely, the value of data showing that many deaths are due to lung disease would be enhanced if it could be determined whether the majority of these deaths are due to infections such as TB, or to cancer.

The major ICD 3-digit classification allows for a combination of organ and disease process, but diagnostic accuracy from post-mortem interviews will be inadequate for classification at this level. On the other hand, the main ICD headings, for example respiratory diseases, cardiovascular diseases, infections, neoplasms and so on, are probably not detailed enough.

A relatively fine classification, with narrow disease categories, is likely to be most useful for policy making and resource allocation. This, however, would require more detailed information on symptomatology than will usually be available. In practice a classification system based on varying levels of detail will probably allow the optimal utilisation of the information available. Narrower categories could be used for those causes for which retrospective data provides sufficient detail. For example, external causes can usually be subdivided reliably into deaths due to road accidents, drowning, burns, violence, suicide and so on. Other causes, that are difficult to distinguish by retrospective interview, could be grouped in broader categories. For example liver diseases might form a category including hepatitis, cirrhosis and liver cancer, since their clinical features and aetiology overlap. The classification scheme would also need to reflect the prevalence of diseases at each site, with narrower categories for common causes of death wherever possible.

Section 3.2.3 raised the possibility that different recall periods and criteria for proximity of residence of the respondent and the deceased might be appropriate for different causes of death. It is envisaged, for example, that most respondents that are able to report whether a specified relative is alive or dead should also be able to report whether the death was due to external causes (possibly broken down into finer categories), maternal causes or other causes. If the survey instrument is designed so that the cause of death questions vary in detail according to the recall period and proximity of residence, it is likely that a separate classification scheme will be needed for each type of data. Thus, a relatively fine categorisation can be adopted for deaths occurring in the past year reported by relatives living close to the deceased, whereas a much broader categorisation will be appropriate when analysing deaths occurring over a longer period and removing the restriction on proximity of residence.

4.6 Validation of techniques

Techniques used for the diagnosis and classification of cause of death by means of retrospective interviews clearly require some form of validation. The ideal approach would be to compare the diagnosis made on the basis of the interview with a diagnosis based on autopsy findings or on the results of a medical examination prior to death. However, many deaths are likely to have occurred without prior medical attention, and autopsies are uncommon in most developing countries. Even when the deceased has received medical attention before death, the medical record may well be inadequate for a confident diagnosis to be reached.

An alternative approach is to conduct a retrospective interview with relatives of patients who have died in hospital, but the results of such a study may be biased if respondents have been given information about the cause of death by hospital staff. An attempt to circumvent this problem was made in a study in the Gambia (Alonso et al, 1988). Mothers of seriously ill children were interviewed at the time of hospital admission, and findings compared with those resulting from subsequent clinical examination and investigation. In 76% of cases, the diagnosis made on the basis of the interview agreed with the subsequent medical diagnosis. Agreement for cases of acute respiratory infection was 84%, and for malaria and chronic diarrhoea or malnutrition 75%. Only two admissions were for acute diarrhoea and agreement was noted in both cases.

Zimicki (1989) reported a validation study in which interviews by lay-reporters were compared with in-depth interviews by physicians. Good agreement was obtained, but it was accepted that two interviews of the same respondent may not be sufficiently independent measures.

A validation study in the Philippines investigated the sensitivity and specificity of diagnostic algorithms when applied to 164 deaths among hospitalised children (Kalter et al, 1989). The diagnosis produced by the algorithm on the basis of an interview with the mother of the dead child was compared with the diagnosis reached by a physician. It was found that the algorithm for measles and that for diarrhoea achieved high sensitivity and specificity, but that for acute lower respiratory tract infections only gave high sensitivity at the expense of specificity and vice versa. Whether sensitivity or specificity is more important must be determined by the clinical situation in each case.

In a review of health interview survey methods, Kroeger (1983) points out that the degree of correspondence between health interviews and validating examinations decreases as the difference between the layperson's and the physician's concepts and terminology increases. Zimicki (1989) supports this with the finding that the lay-reporting system works well for conditions such as diarrhoea where the diagnosis and the perception of the illness correspond.

4.7 Presentation of data

Methods of data presentation should be chosen with regard to their value for policy makers. Whatever classification scheme is decided upon, it is likely that a range of differing categorisations of cause of death would be incorporated in the survey report. Causes might, for example, be grouped according to the availability of cost-effective preventive or curative interventions. Such a categorisation might be of special value to policy makers involved in decisions on resource allocation in the health sector.

The raw data from a survey of adult mortality would provide information on proportionate mortality rates, in other words, the proportion of adult deaths attributed to each cause. If combined with an estimate of the overall adult mortality rate, which could be obtained from the same survey using indirect demographic methods, overall cause-specific mortality rates could be estimated.

The data should also be tabulated by sex and by broad age-groups, giving age- and sex-specific proportionate mortality and cause-specific mortality rates. It is likely that the distribution of causes of death varies considerably with age and sex, as illustrated in Section 2.4. Geographical variations in rates may also be of interest. There are, however, limits to the subdivision of data given the limited number of deaths likely to be available for analysis.

Proportionate mortality analysis essentially gives equal weight to all adult deaths. An alternative is to present causes of death according to person years of life lost (PYLL) from each cause, thus giving more weight to deaths occurring early in adulthood. Two examples of this approach are illustrated in Table 9.

The first is based on deaths occurring in state capitals in Brazil in 1984. In this study, a maximum age of 70 years was used to define "premature mortality", and so the persons years of life lost for each death was calculated as 70 minus the age of the deceased. The choice of 70 years is, of course, essentially arbitrary, and different limits have been used in different studies. Childhood deaths were included in the construction of this table, but a PYLL analysis could in principle be conducted for adult deaths only. Intestinal infections were the leading cause of death in terms of PYLL. From column 2, PYLL per death, it is clear that the majority of these deaths occurred in children. Cerebrovascular and ischaemic heart disease, which ranked highly according to proportionate mortality, appear less important in terms of PYLL because deaths from these causes occur later in life. Among adults, external causes were associated with the greatest number of years lost per death (about 40 per death), indicating that such deaths are relatively common in young adults. Neoplasms ranked highly in terms of both PYLL and proportionate mortality. The number of years lost per death (about 19) was relatively low, but deaths from this cause occurred with great frequency.

The second example, from Ghana, is based on days of life lost per thousand per year, and has been constructed from data published by the Ghana Health Assessment Project Team (1981). The team used life tables for Ghana to establish the potential remaining years of life from the average age of onset of each cause. Estimates of days of life lost have been calculated by multiplying the published estimates of "days of healthy life lost" by the percentage of these days attributed to premature mortality. Only causes of death with an average age of onset of 15 years or more have been included in Table 9. Accidents again appear as the leading cause of adult death in terms of days of life lost, closely followed by TB.

A possible difficulty with rankings based on proportionate mortality and PYLL is that they are affected by the age structure of the population. In a population with a rapid rate of growth, the population in younger age-groups will be much greater than in older age-groups, and this will be reflected in the numbers of deaths occurring in these age-groups. Thus it is possible to envisage a situation in which accidents appear as the leading cause of death on the basis of proportionate mortality or PYLL, but in which any given individual is more likely to die from, say, heart disease than from an accident. One approach which avoids dependence on the age structure of the population is to work in terms of the index $_{50}q_{15}$, which represents the probability of dying by age 65 for an individual that has survived to age 15. Causes of death could be ranked according to their proportional contribution to this index.

5.0. RECOMMENDATIONS FOR FURTHER RESEARCH.

It should be clear from preceding sections that if single-round surveys, using retrospective interviewing of relatives of the deceased, are to be implemented on a wide scale to obtain useful and comparable data on causes of adult mortality for a range of developing countries, a considerable amount of theoretical and methodological work will be needed to develop effective survey methods. Various aspects of this work are summarised briefly in this section.

Various sources of bias associated with variations in the probability of a death being reported, resulting from a survey approach based on the questioning of surviving relatives, have already been reviewed. These biases, and measures to reduce them, require further investigation. A study of anthropological sources to determine family structure and living patterns may be necessary in this connection.

The following three methodological questions require further empirical investigation: (i) the effect of the recall period on the reliability of diagnosis; (ii) the effect of differences in proximity of residence between the respondent and the deceased prior to the death; and (iii) the use of medical or lay interviewers. The choice of interviewer may influence the type of questionnaire required. Lay interviewers will require a highly structured questionnaire, and considerable effort will need to be devoted to the development of a suitable instrument. If diagnostic algorithms are to be used, this too will require a considerable amount of development work. It may be desirable to use structured questionnaires or algorithms even if physicians are used as interviewers, but this point requires further research.

Preliminary field tests will be required to pilot the questionnaire and to collect empirical data with respect to the methodological questions listed above. Several approaches are possible:
a) A study of adults admitted to hospital with life-threatening diseases. The diagnosis based on an interview with the relative who had been caring for the patient prior to admission could be compared with the final medical diagnosis. If it were possible to interview relatives immediately at the time of admission, preferably before they were questioned by medical staff, their responses should not be influenced by medical contact, although selection biases would still operate.
b) A similar study could be conducted by interviewing relatives of patients who had recently died in the hospital while the relative was still at or near the hospital. This may not prove feasible because it may be considered inappropriate to intrude immediately after a relative has been bereaved.
c) A retrospective study of hospital deaths over a period of time could be conducted if the hospital records were adequate to allow tracing of a close relative and to allow an accurate medical diagnosis to be extracted from the notes.
Whichever approach is adopted, both lay and medical interviewers could be employed, and a comparison made of their findings. Approach (c) would be especially useful for investigation of the effects of differing recall periods and proximity of residence of the respondent and deceased.

Following this preliminary testing, and further development and modification of the survey instrument, a full scale field trial of the methodology would need to be carried out in a developing country, preferably in an area where alternative sources of information on adult mortality would allow validation of the results. Further investigation of methodology could be incorporated in the field trial itself, for example by allowing the time and proximity criteria for questioning of relatives to be more relaxed than would finally be envisaged, so that the effects of differing criteria could be examined.

ACKNOWLEDGEMENTS

This paper was commissioned by the World Bank as a background document for the work of the Population, Health and Nutrition Division on adult mortality. The authors wish to thank Ian Timaeus, Basia Zaba and Richard Feachem for their helpful comments on early drafts of the paper.

REFERENCES

Alderson M.R. and Meade J.W. (1967) Accuracy of diagnosis on death certificates compared to hospital records. Brit J Prev Soc Med 21, 22-29.

Alonso P.L., Bowman A., Marsh K. and Greenwood B.M. (1987) The accuracy of the clinical histories given by mothers of seriously ill African children. Ann Trop Paediatr 7 (3), 187-9.

Ayeni O. (1980) Causes of mortality in an African city. Afr J Med med Sci 9, 139-49.

Blacker G.C. (1984) Experiences in the use of special mortality questions in multi-purpose surveys: The single-round approach. in Data Bases for Mortality Measurement. United Nations.

Borges da Silva G. (1987) Evaluation de la mortalite chez les ouvriers senegalais. Bull Soc Pathol Exot Filiales 80 (4), 698-703.

Botha J.L. and Bradshaw D. (1985) African vital statistics - a black hole? SAMJ 67, 15 June, 977-81.

Bradley A.K. and Gilles H.M. (1984) Malumfashi endemic diseases research project XXI: Pointers to causes of death in the Malumfashi area, northern Nigeria. Ann Trop Med Parasitol 78 (3), 265-71.

Essex B.J. (1980) Diagnostic Pathways in Clinical Medicine. Edinburgh: Churchill Livingstone.

Fargues P. and Nassour O. (1987) Les saisons et la mortalite urbaine en Afriques: les deces a Bamako de 1974 a 1985. Paper presented to IUSSP seminar on mortality and society in sub-Saharan Africa, 19-23 October, Yaounde, Cameroon.

Fuller J.H. (1985) Causes of death in diabetes mellitus. Horm Metab Res (Suppl) 15, 3-9.

Garenne M. and Fontaine O. (1986) Assessing probable causes of death using a standardized questionnaire. Paper presented to the IUSSP seminar on comparative studies of mortality and morbidity, Sienna, 7-12 July.

Ghana Health Impact Assessment Project Team. (1981) Quantative method of assessing the health impact of different diseases in less developed countries. Int J Epidemiol 10 (1), 73-80.

Graham W., Brass W. and Snow R.W. (1988) Indirect estimation of maternal mortality: The sisterhood method. CPS Research Paper 88-1. Centre for Population Studies. London School of Hygiene and Tropical Medicine.

Greenwood B.M., Bradley A.K., Greenwood A.M., Byass P., Jammeh K., Tulloch S., Oldfield F.S.J. and Hayes R. (1987a) Mortality and morbidity from malaria among children in a rural area of the Gambia, West Africa. Trans Roy Soc Trop Med Hyg 81, 478-86.

Greenwood B.M., Greenwood A.M., Bradley A.K., Tulloch S., Hayes R. and Oldfield F.S.J. (1987b) Deaths in infancy and early childhood in a well vaccinated, rural, West African population. Ann Trop Paediatr 7, 91-99.

Grosse R.N. (1980) Interrelation between health and population: Observations derived from field experiences. Soc Sci & Med 14C, 99-120.

Grubb G.S., Fortney J.A., Saleh S., Gadalla S., el-Baz A., Feldblum P. and Rogers S.M. (1988) A comparison of two cause-of-death classification systems for deaths among women of reproductive age in Menoufia, Egypt. Int J Epidemiol 17 (2), 385-91.

Kachirayan M., Radhakrishna S., Ramakrishnan R., Ramanathan A.M. and Sreenivas V. (1983) Study of registered deaths in Madras city. Indian J Med Res, 77, April, 564-73.

Kalter H.D., Gray R.H. and Black R.E. (198?) Validation of a postmortem interview method to ascertain selected causes of death in children in The Phillipines. Int J Epidemiol (in press).

Kircher T., Nelson J. and Burdo H. (1985) The autopsy as a measure of accuracy of the death certificate. N Engl J Med 313 (20) 1263-9.

Kroeger A. (1983) Health interview surveys in developing countries: A review of the methods and results. Int J Epidemiol 12 (4) 465-481.

Muller A.S. and van Ginneken J.K. (1989) Morbidity and mortality at Machakos, Kenya, 1974-1981: a policy-oriented study of health in rural communities incorporating a pertussis vaccine trial. In Disease and Mortality in Sub-Saharan Africa. Ed. R.G. Feachem and D. Jamison. Oxford: Oxford University Press (in press).

PAHO. (1988) Health Profiles, Brazil, 1984. in Epidemiological Bulletin 9 (2) 6-12.

Preston S.H. (1976) Introduction: Nature of the data base, in Mortality Patterns in National Populations. London: Academic Press Inc.

Ties Boerma J. (1987) Maternal mortality in sub-Saharan Africa: Levels, causes and interventions. Paper presented to the IUSSP seminar on mortality and society in sub-Saharan Africa, October 19-23. Yaounde, Cameroon.

Timaeus I. and Graham W. (1989) Measuring adult mortality in developing countries: A review and assessment of methods. CPS Research Paper 88-4 London School of Hygiene and Tropical Medicine.

United Nations. (1983) Estimation of adult survivorship probabilities from information on orphanhood and widowhood, in Indirect Techniques for Demographic Estimation. Manual X. New York: United Nations.

Williams E.H., Hayes R.J. and Smith P.G. (1986) Admissions to a rural hospital in the West Nile district of Uganda over a 27 year period. J Trop Med Hyg 89 193-211.

World Health Organization. (1978) Lay reporting of health information. Geneva: WHO.

World Health Organization. (1980) World Health Statistics Annual 1980-1981. Geneva: WHO.

World Health Organization. (1987) World Health Statistics Annual 1987. Geneva: WHO.

Zimicki S. (1989) Approaches to assessment of the cause structure of mortality: A case study from Bangladesh. Paper presented to the Johns Hopkins University seminar on verbal autopsies, Baltimore, 13-15 March 1989.

Table 1. Leading causes of death in Belo Horizonte, Brazil, 1984, using different classification lists. Table shows percentage of deaths in each category.

	ICD-BR List	%	R List	%	ICD-BR2 List	%	NCHS List	%
1.	Neoplasms (140-208)	12.5	Heart dis. (390-429)	20.0	Neoplasms (140-208)	12.5	Heart dis. (390-8,402, 404-29)	19.2
2.	Cerebrovasc (430-430)	10.7	Neoplasms (140-208)	12.5	Cerebrovasc (430-438)	10.7	Neoplasms (140-208)	12.5
3.	Other Resp. (466,480-519)	9.3	Cerebrovasc (430-438)	10.7	Perinatal (760,771.2, 771.4-779)	9.2	Cerebrovasc (430-438)	10.7
4.	Perinatal (760-779)	9.2	Accidents (E800-949, 980-989)	7.8	PC/Oth HD (415-429)	9.0	Perinatal (760-779)	9.2
5.	PC/Oth HD (415-429)	9.0	Perinatal (760-769)	4.8	IHD (410-414)	7.6	Accidents (E800-949)	6.5
6.	IHD (410-414)	7.6	Flu/Pneumonia (480-487)	4.5	Flu,Pneum,ARI (460-466, 480-487)	4.6	Flu/Pneumonia (480-487)	4.5
7.	Digestive (520-579)	5.4	Intest.inf. (007-009)	3.3	Road accident (E810-819)	4.0	COPD (490-496)	3.1
8.	Tran.acc. (E800-848)	4.0	Nutritional (260-269)	3.1	Nutri/anaemia (260-269,280-281,285)	3.8	Nutritional (260-269)	3.1
9.	Intest.inf. (001-009)	3.3	Diabetes (250)	2.6	Intest.inf. (001-009)	3.3	Diabetes (250)	2.6
10.	EM & ID (240-259, 270-79)	3.1	Chronic liver (571)	2.5	COPD (490-496)	3.1	Chronic liver (571)	2.5

Source: PAHO (1988)

Key: COPD = Chronic obstructive pulmonary disease, IHD = Ischaemic heart disease, Tran.acc. = Transport accident, ARI = Acute respiratory infection, PC/Oth HD = Diseases of pulmonary circulation/other forms of heart disease, EM & ID = Endocrine/metabolic and immune disorders.

Table 2. Leading causes of death in adults aged 15-64 years from vital registration data in selected developing countries.

Rank	Guatemala 1984	%	Mauritius 1986	%	Thailand 1978	%	Egypt 1975	%	Sri Lanka 1982 [2]	%
1.	Infectious/ parasitic [1]	19.7	Circulatory	31.3	External	21.3	Circulatory	36.5	External	24.0
2.	External	18.2	External	13.1	Infectious/ parasitic	7.3	External	10.2	Circulatory	18.5
3.	Pneumonia	7.7	Cerebrovasc.	11.2	Circulatory	6.1	Other GI	7.2	Neoplasms	7.4
4.	Circulatory	7.4	Neoplasms	9.5	Other respir.	6.0	Other respir.	6.6	Infections/ parasitic	5.0
5.	Neoplasms	6.8	Diabetes	7.5	Other GI	5.1	Neoplasms	5.7	Cerebrovasc.	2.3
6.	Protein-cal. malnutrition	5.2	Other respir.	4.9	Neoplasms	4.4	Genit/urinary	3.7	Tuberculosis	2.3
7.	Other respir.	3.5	Chronic liver	4.2	TB	4.3	Chronic liver	2.9	Mental dis.	0.5
8.	Other endocrine	3.2	Other GI	4.0	Cerebrovasc.	2.4	Infectious/ parasitic	2.3	Maternal	0.2
9.	Tuberculosis	3.1	Genit/urinary	2.8	Neurological	1.8	Pneumonia	1.8		
10.	Chronic liver	3.0	Pneumonia	2.2	Genit/urinary	1.8	Cerebrovasc.	1.6		
11.	Other GI	2.5	Infectious/ parasitic	1.7	Pneumonia	1.4	Diabetes	1.5		
12.	Cerebrovasc. Mental dis.	2.1 2.1	Neurological	1.2	Chronic liver	1.4	Neurological	1.4		
Ill-defined		9.1		2.3		21.4		13.9		?
Total deaths 15-64 years.		17724		2833		101079		104123		33004

Source: WHO (1980), WHO (1987).

Notes: [1] Grouping of diseases in relation to ICD-9 Basic Tabulation List: Infectious and parasitic diseases 01-07 except 021-025,029 (TB); External causes E47-56; Circulatory diseases 25-30 except 29 (cerebrovascular); Malignant neoplasms 08-14; Pneumonia 321; Other respiratory diseases 310-315,319,320,322-327,329; Other endocrine and metabolic diseases 180,182,183,189; Diabetes 181; Other gastro-intestinal diseases 33,340-346,348-349; Neurological diseases 221-229,23,24; Genito-urinary diseases 350-353,359,363,369,37; Maternal causes 38,390-394,399,40,41.

[2] Figures for Sri Lanka appear incomplete.

Table 3. Leading causes of death by sex in adults aged 15-64 years in Egypt and Guatemala.

	Guatemala 1984				Egypt 1975			
	Males		Females		Males		Females	
Total deaths	10484		7240		68421		35702	
1.	External	26.8	Infect/ parasit	18.8	Circul.	34.7	Circul.	30.6
2.	Infect/ parasit	16.9	Neoplasm	10.3	External	11.3	External	8.3
3.	Circul.	7.0	Pneumonia	9.5	Other GI	8.1	Pneumonia	6.2
4.	Pneumonia	6.5	Circul.	8.0	Resp.	6.9	Other GI	5.8
5.	Neoplasm	5	PCM	6.8	Neoplasm	6.0	Neoplasm	5.0
6.	PCM	4.0	External	5.8	Gen/urin	3.7	Gen/urin	3.6
7.	Liver	3.8	Resp.	4.2	Liver	3.3	Maternal	2.7
8.	Mental	3.2	Endocrine	3.8	Infect/ parasit	2.4	Infect/ parasit	2.1
9.	TB	3.1	Maternal	3.1	TB	1.9	Liver	2.0
10.	Resp.	3.0	TB	3.0	Pneumonia	1.7	Diabetes	2.0
11.	Endocrine	2.9	Cerebrov.	2.8	Cerebrov.	1.5	Pneumonia	1.9
12.	Other GI	2.4	Other GI	2.6	Diabetes	1.3	TB	1.6

Source: WHO (1980), WHO (1987).
Notes: Disease categories as in Table 2. Abbreviations: Resp.= other respiratory diseases, Endocrine = other endocrine diseases, PCM = protein-calorie malnutrition, Circ.= circulatory diseases, Other GI = other diseases of the gastro-intestinal tract.

Table 4. Leading causes of death in selected African countries from vital registration data

	South Africa (black population) 15-64 years		Lagos Nigeria 15+ years		Bamako Mali 15-64 years	
Rank		%		%		Rate [1]
1.	External	30	Road accident	26.3	Liver disease	1.32
2.	Circulatory	18	Circulatory	19.7	Cardiac insuf.	0.86
3.	Neoplasms	14	Pneumonia	6.1	TB	0.70
4.	Inf/parasitic	11	Dia/dysentery	5.2	Intest.inf.	0.62
5.	Respiratory	10	Maternal	4.5	Malaria	0.36
6.			Inf/parasitic	3.4	Pneumonia	0.26
7.			Neoplasms	3.3	Meningitis	0.16
8.			Malaria	2.3	Dehydration	0.16
9.					Anaemia	0.14
Ill-defined		20				
Total deaths		99469		5219		
Source:	Botha & Bradshaw (1985)		Ayeni (1980)		Fargues & Nassour (1987)	

Notes: [1] Death rate/1000/year in age group 15-64 years

Table 5. Leading causes of death reported in specially conducted studies in selected developing countries.

	Madras India		West Nile Uganda		Machakos Kenya		Senegal		Ghana	
Age:	15-44 years		12+ years		Over 5 years		Adult workers			
Rank		%		%		%		%		Rate [1]
1.	TB	16.0	Schistosomia.	13.0	Circulatory	14.4	Neoplasms*	17.1	Cardiovasc.	106.5
2.	Suicide	15.9	Pneumonia	6.0	TB	12.4	Circulatory	16.5	Cerebrovasc.	80.5
3.	Cardiovasc.	13.0	Gastrointest.	6.0	Neoplasms	7.4	Work accident	12.8	Accidents	77.0
4.	Inf/parasitic	5.4	Diarrhoea	3.5	Hepatitis	7.4	Other accid.	10.4	Other GI	75.8
5.	Neoplasms	5.4	Ancylostoma	3.1	Pneumonia	6.2	Inf/parasitic	6.7	Pneumonia	70.0
6.	Accidents	5.1	Anaemia	2.9	Other respir.	5.9	Hepatitis	6.1	TB	70.0
7.	Maternal	4.8	Meningitis	2.6	Cirrhosis	5.0	Cirrhosis	5.5	Neoplasms	52.0
8.	Diarrhoea	4.0	Neurological	0.9	Other accident	4.1	Respiratory	4.3	Cirrhosis	52.0
9.	Cirrhosis	3.0	Nutritional	0.6	Inf/parasitic	7.4			Maternal	31.2
10.	Nutritional	2.6	Malaria	0.4	Motor accident	3.5			Typhoid	29.2
Ill defined/symptoms		7.3		5.9		10.9		20.7		
Total deaths		1866		679		340		164		

	Madras India	West Nile Uganda	Machakos Kenya	Senegal	Ghana
Type of data:	Hospital/clinic deaths.	Rural hospital data.	Population surveillance data.	9 year prospective study of factory workers.	Vital registration, health centre data, special studies.
Comments:		Restricted to causes of 30 or more deaths.		*Liver cancer 13% of all deaths.	Based on diseases with average age at onset of 15 yrs. or more.
Source:	Kachirayan et al. (1983)	Williams et al. (1986)	Muller & van Ginneken (1989)	Borges da Silva (1987)	Ghana Health Impact Assessment Project Team (1981)

Notes: [1] Death rate/100,000/year (all ages).

Table 6. Deaths in adults aged 15-44 years in selected developing countries.

Rank	Pakistan (Punjab)	%	Indonesia (E.Java)	%	Ghana (E.Region)	%	Nepal (Terai)	%
1.	Enteric fever	40	Maternal	20	Circulatory	16	TB	36
2.	Maternal	20	Dia/cholera	17	Dia/cholera	16	Anaemia	15
3.	TB	15	Typhoid	15	Maternal	15	Respiratory	14
4.	Dia/cholera	10	TB	15	TB	10	Dia/cholera	11
5.	Malaria	10	Circulatory	12	Meningitis	9	Tetanus	11
6.	Respiratory	3	Malaria	7	Cirrhosis	8	Acute abdo.	6
7.	Circulatory	1	Respiratory	5	Typhoid	8	Accidents	4
8.	Genito-urinary	1	Tetanus	3	Hepatitis	4	Maternal	2
9.					Respiratory	4		
10.					Yellow fever	3		
Other		0		4		7		1
Total		100		100		100		100

Source: Grosse (1980).

Table 7. Selected symptoms and common associated causes of death.

BREATHLESSNESS	**COUGH**
Pneumonia	Pneumonia
Asthma	Asthma
Chronic obstructive airways disease	Chronic obstructive airways disease
Cardiac failure	Cardiac failure
Pneumothorax	
Diabetic keto-acidosis	
Pleural effusion	
Tuberculosis	Tuberculosis
DIFFICULTY/NOT PASSING URINE	**BLOOD IN URINE**
Dehydration	
Acute renal failure	
Bladder stone	Bladder stone
Urethral stricture	
Enlarged prostate, benign or malignant	Carcinoma of prostate
Obstruction due to cancer of rectum or cervix	
	Cancer of bladder or kidney
Urinary tract infection	Urinary tract infection
	Schistosomiasis
	Acute nephritis
Trauma	Trauma
	*Malaria
SEMI/UNCONSCIOUSNESS	**FEVER**
Trauma	
Meningitis	Meningitis
Encephalitis	Encephalitis
Cerebral malaria	Cerebral malaria
Vascular (Stroke)	
Tumours, metastatic/primary	Tumours, metastatic/primary
Diabetes	
Liver failure	
Epilepsy	
Drugs	
Cholera	Any other infection

* In some forms of malaria urine appears bloody but the colour is due not to blood but to haemoglobin.

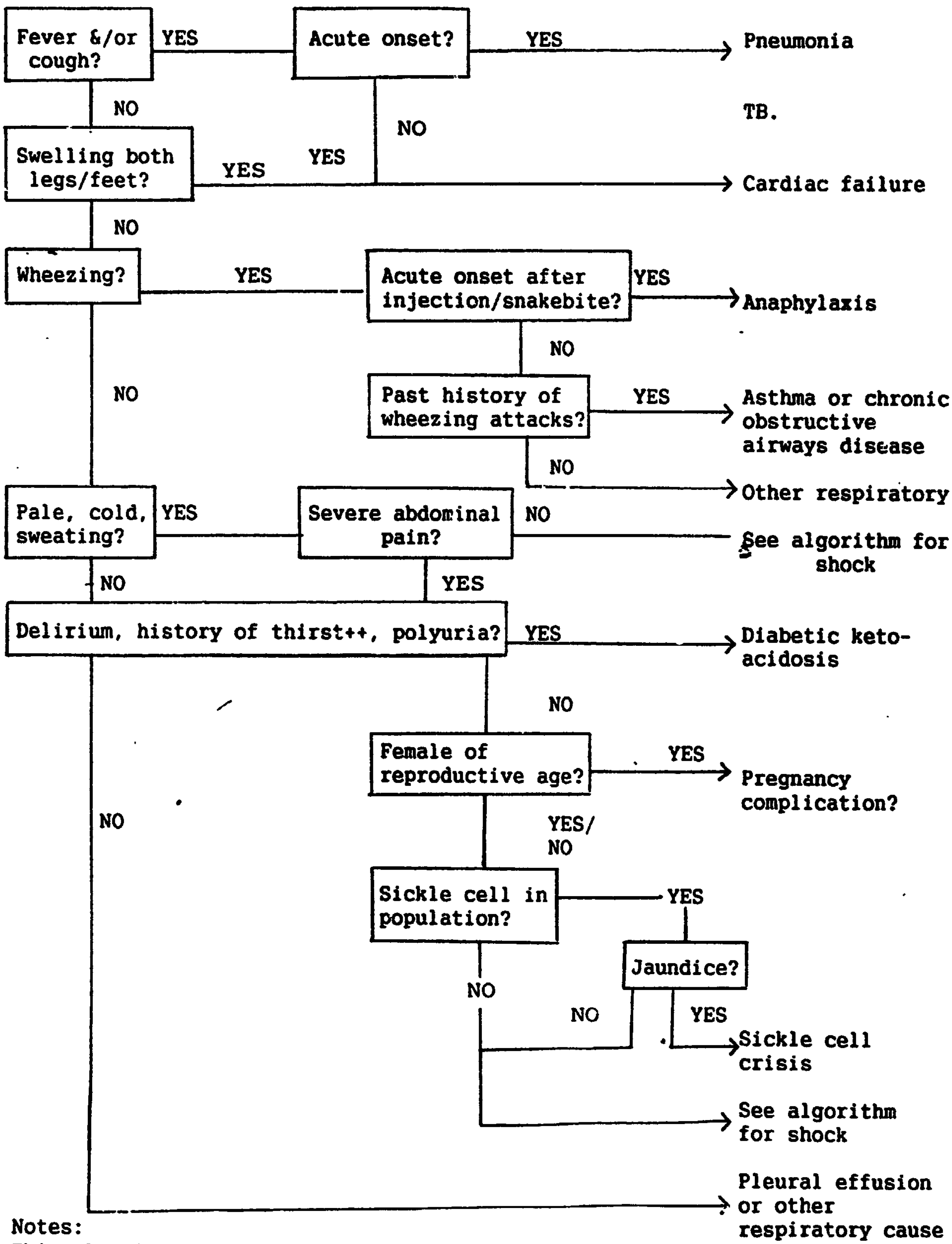
Table 8. Ability to diagnose or exclude some of the major causes of adult deaths, based on symptoms reported by bereaved relatives.

CAUSE	ABILITY TO DIAGNOSE		ABILITY TO EXCLUDE	
Circulatory diseases				
Stroke	Yes	If sudden paralysis or loss of speech leading to unconsciousness	No Yes	From other causes of loss of consciousness If no suggestive history.
Hypertension	No		No	
Cardiac failure	Yes	Exertional dyspnoea, oedema, orthopnoea	Yes	If no oedema or dyspnoea.
Coronary heart disease (CHD)	?	If history of typical pain but can be difficult even with living patient.	No Yes	Any unexplained sudden death could be provoked by CHD. If history of chronic disease leading to death without pain.
Maternal causes	Yes	If during labour or delivery with haemorrhage, prolonged labour, convulsions. If fever in six weeks after delivery. If fever after abortion. Abortion deaths may be concealed.	Yes No	In late pregnancy labour or immediate post-partum. In early pregnancy
Malignant neoplasms			Yes	If untreated and no weight loss
Breast	?	If no cultural problem about an intimate area. Could be confused with chronic infection.	Yes	If relative knew intimate history.
Uterus/cervix	?	In post-menopausal period only History may not be forthcoming to male interviewer.	No	
Lung	?	Weight loss, coughing blood, fever also present tuberculosis but tuberculosis history longer and fever low grade.	Yes	If no cough, no weight loss, no haemoptysis.
Liver	?	Cannot distinguish from terminal cirrhosis	Yes	If no vomiting, no jaundice, swollen abdomen or diarrhoea
Stomach	No	Confuse with chronic peptic ulcer, pyloric stenosis.	Yes	If no weight loss, no vomiting, no history of loss of appetite.

Table 8. Continued

CAUSE	ABILITY TO DIAGNOSE		ABILITY TO EXCLUDE	
Colon	No	Confuse with other causes of intestinal obstruction or anaemia but other causes more acute	?	
Respiratory diseases				
Pneumonia	Yes	If dyspnoeic at rest, high fever, +/- cough or chest pain	Yes	If none of the symptoms present
Asthma	Yes	Especially in young person, typical wheeze, cyanosis, unable to drink more than sips, history of past recurrent episodes	Yes	If not breathless at time of death (although wheeze less apparent at terminal stage)
Bronchitis/emphysema	Yes	Cough and wheeze +/- fever, history of recurrent episodes 3/year. Differential diagnosis with asthma.	Yes	If no relevant symptoms at time of death.
Infections				
TB	Yes	Cough, blood in sputum weight loss, fever, night sweats, anorexia (possible confusion with lung cancer)	Yes No	If no related symptoms. From lung cancer.
AIDS	Yes	If weight loss, fever, chronic diarrhoea, oral candidiasis, cough, +/- herpes zoster. Kaposi's sarcoma may be locally recognised.	No Yes	When symptoms suggestive of TB. If none of the symptoms.
Malaria	Yes Yes	If cerebral malaria headache, high fever, shivering attacks, delirium, especially in someone recently arrived from non-malarial area. If blackwater fever.	Yes	If only slight or no fever
Hepatitis	Yes	If anorexia and nausea +/- vomiting, fever, followed by jaundice.	Yes	If no related symptoms Possible confusion or with gall stones infection, but pain severe in that case.

Figure 1. Diagnostic algorithm for breathlessness



Notes:
This algorithm assumes external and obvious maternal causes excluded.
Based on algorithms designed for clinical use by Essex (1980).

PPR Working Paper Series

	Title	Author	Date	Contact for paper
WPS216	Price and Quality Effects of Vers--Revisited: A Case Study of Korean Footwear Exports	Jaime de Melo L. Alan Winters	June 1989	M. Ameal 61466
WPS217	Public Debt, North and South	Helmut Reisen		
WPS218	Public Finance, Trade and Development: The Chilean Experience	Vittorio Corbo	July 1989	A. Oropesa 61758
WPS219	Rural Credit in Developing Countries	Avishay Braverman J. Luis Guasch	June 1989	C. Spooner 37570
WPS220	Capacity Building for Policy Analysis	Samuel Paul David Steedman Francis X. Sutton	July 1989	E. Madrona 61712
WPS221	How Does Uncertainty About the Real Exchange Rate Affect Exports?	Ricardo J. Caballero Vittorio Corbo	June 1989	A. Oropesa 61758
WPS222	Why Stabilisation Policies in Zambia Did Not Succeed	Christopher Colclough		
WPS223	Overvalued and Undervalued Exchange Rates in An Equilibrium Optimizing Model	Jose Saul Lizondo		
WPS224	The Economics of the Government Budget Constraint	Stanley Fischer	May 1989	S. Fischer 33774
WPS225	Targeting Assistance to the Poor: Using Household Survey Data	Paul Glewwe Oussama Kanaan	June 1989	B. Rosa 33751
WPS226	Inflation and the Costs of Stabilization: Historical Cases, Recent Experiences and Policy Lessons	Andres Solimano		
WPS227	Institutional Reforms in Sector Adjustment Operations	Samuel Paul		
WPS228	Economic Performance of Developing Countries in the 1980s	Robert Lynn F. Desmond McCarthy		
WPS229	The Effect of Demographic Changes on Saving for Life-Cycle Motives in Developing Countries	Steven B. Webb Heidi Zia	July 1989	E. Khine 61765
WPS230	Unemployment, Migration and Wages in Turkey, 1962-1985	Bent Hansen	July 1989	J. Timmins 39248
WPS231	The World Bank Revised Minimum Standard Model	Doug Addison	May 1989	J. Onwuemene-Kocha 61750

PPR Working Paper Series

	Title	Author	Date	Contact for paper
WPS232	Women and Food Security in Kenya	Nadine R. Horenstein	June 1989	M. Villar 33752
WPS233	Public Enterprise Reform in Adjustment Lending	John Nellis		
WPS234	A Consistency Framework Macroeconomic Analysis	William Easterly	June 1989	R. Luz 61760
WPS235	Borrowing, Resource Transfers and External Shocks to Developing Countries: Historical and Counterfactual	Steven Webb Heidi Zia	July 1989	E. Khine 61765
WPS236	Education and Earnings in Peru's Informal Nonfarm Family Enterprises	Peter Moock Philip Musgrove Morton Stelcner	July 1989	M. Fisher 34819
WPS237	The Curricular Content of Primary Education in Developing Countries	Aaron Benavot David Kamens	June 1989	C. Cristobal 33640
WPS238	The Distributional Consequences of a Tax Reform on a VAT for Pakistan	Ehtisham Ahmad Stephen Ludlow		
WPS239	The Choice Between Unilateral and Multilateral Trade Liberalization Strategies	Julio Nogues	July 1989	S. Torrijos 33709
WPS240	The Public Role in Private Post-Secondary Education: A Review of Issues and Options	Ake Blomqvist Emmanuel Jimenez		
WPS241	The Effect of Job Training on Peruvian Women's Employment and Wages	Ana-Maria Arriagada	July 1989	C. Cristobal 33640
WPS242	A Multi-Level Model of School Effectiveness in a Developing Country	Marlaine Lockheed Nicholas Longford		
WPS243	Averting Financial Crisis - Kuwait	Fawzi Hamad Al-Sultan		
WPS244	Do Caribbean Exporters Pay Higher Freight Costs?	Alexander Yeats	July 1989	J. Epps 33710
WPS245	Indigenous Peoples and Conservation: A Study of Overlapping Interests and their Implications for Land Use Planning and Indigenous Policies in Latin America	Peter Poole		
WPS246	Causes of Adult Deaths in Developing Countries: A Review of Data and Methods	Richard Hayes Thierry Mertens Geraldine Lockett Laura Rodrigues	July 1989	S. Ainsworth 31091